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ABSTRACT

Guidelines are provided for writing science instructional objectives included in Department of Defense Dependent Schools (DODDS) Pacific Region science objective guides. Revision of the objectives is perhaps the most important part of the curriculum review that occurs for the DODDS once each 7 years. To provide a manageable system of objectives, the DODDS has consolidated the cognitive domain taxonomy of B. Bloom into knowledge and intellectual processes. Two other domains, the affective and the psychomotor, are added. Four levels of objectives incorporate these domains in DODDS science programs: general; program; instructional; and enabling. The level of specificity increases as one proceeds from general to enabling objectives. Instructional and enabling objectives are written in student-centered terms, describing what student behavior should be after some period of instruction. An objective generally contains three parts: (1) a stem, stating the desired behavior; (2) conditions, under which the identified behavior is to be evaluated; and (3) criteria, or standards of acceptable performance students must demonstrate. There are at least four types of content objectives: procedures; rules; concepts; and facts. This document is not intended to be an all-inclusive source for writing objectives, but is intended to stimulate thought. (SLD)

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DESIGNING LEARNING OBJECTIVES

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PURPOSE

This document provides guidance for writing science instructional objectives included in Department of Defense Dependent Schools (DoDDS) Pacific Region science objective guides. It is, however, not all inclusive.

INTRODUCTION

Once, during each seven-year period, the objectives of each academic discipline included in the DoDDS curriculum are reviewed for currency, quality and sufficiency. The objectives are examined in light of:

1. Changes in science, technology and society having occurred since the last review and revision.
2. Changes in science, technology and society projected to occur during the coming seven-year period.
3. Whether or not the objectives are written in student centered, measurable terms.
4. Whether or not the objectives are sufficient to support science program goals.
5. Student needs.
6. Instructional needs.

After the revision process has been completed, a revised objectives booklet is published for the discipline. The revised objectives are used when selecting new textbooks and curriculum materials. Revision of the objectives, therefore, is perhaps the

most important part of the curriculum review cycle. The objectives, once revised, are the focal point of the revised or new science program. Text books and materials purchased subsequent to the review and revision process all must help facilitate conceptualization of the objectives by students.

OBJECTIVES (GENERAL)

There are three well described learning domain taxonomies found in the literature: the cognitive domain, the affective domain and the psychomotor domain. The cognitive domain, developed by Benjamin Bloom, is a hierarchy of advancing sophistication which includes the following levels: knowledge, comprehension, application, analysis, synthesis and evaluation. The knowledge level, therefore, is the least sophisticated, requiring students only to accomplish such tasks as fact memorization. In order to provide a manageable system of objectives, which includes all three domains, the DoDDS system has consolidated Bloom's taxonomy into two categories as is shown in Figure 1:

Bloom's Taxonomy	DoDDS Consolidation
Knowledge	Knowledge
Comprehension	
Application	
Analysis	Intellectual Processes
Synthesis	
Evaluation	

Figure 1. Consolidation of Bloom's Taxonomy

Using the consolidation scheme and the two other learning domains, the objectives used by the DoDDS system are categorized as:

1. Knowledge.
2. Intellectual processes (of varying sophistication).
3. Attitudes and values (affective domain; levels of sophistication also exist here).
4. Psychomotor skills (psychomotor domain; again there is a hierarchy of sophistication).

Levels of Objectives: Four levels of objectives are used in DoDDS science programs. They are general, program, instructional, and enabling objectives. The level of specificity increases as one proceeds from general to enabling objectives. We thus would expect an education program to have a few general objectives, more program objectives, a still higher number of instructional objectives and so on. As an example, the DoDDS science program for the years 1985-1992 has four general objectives, 25 program objectives and 146 instructional objectives.

Moving from general to specific categories, objectives in a more specific category are subsets of the objectives in the categories directly above them or those which they support. Using a numbering scheme, we might expect the hierarchy to appear like the one shown in Figure 2.

General	4.0	EXHIBIT scientific behavior in school and everyday life.
Program	4.1	VALUE the scientific process
Instructional	4.2.01	
	4.2.02	
	4.2.03	
	4.2.04	
	4.2.05	
	4.2.06	DISTINGUISH between scientific and non-scientific explanations of phenomena.
Enabling	4.2.06.01	
	4.2.06.02	
	4.2.06.03	
	4.2.06.04	STATE that the moon is composed of minerals based upon evidence collected by astronauts.

Figure 2. The Numbering Scheme.

TYPES OF OBJECTIVES

1. General Objectives: General objectives are objectives specific to a particular curriculum category (science, mathematics, etc.). They are general statements of long term results with which students should manifest minimum competence at or near the conclusion of their tenure in a program. Our aim with these objectives is to identify a list of learning outcomes to work toward and not a list of specific types of behavior to be attained by all students. The degree to which an educational program is deemed successful is based upon these objectives. Examples of some verbs used in writing general objectives are: comprehends, understands, applies, knows, uses. Specifically,

general objectives are:

a. Limited in number. The number, however, must adequately define the discipline. In this case science K-12 in DoDDS.

b. Classified as meeting one of the following purposes (the complete set for science must address all five purposes):

(1) Personal competency

(2) Social competency

(3) Vocational competency

(4) Environmental competency

(5) Learning competency

c. Classified in one of the following categories (a complete set of objectives includes objectives in all four categories):

(1) Knowledge

(2) Intellectual processes

(3) Attitudes and values

(4) Psychomotor skills

2. Program Objectives: Program objectives are subsets of general objectives. They, therefore, are more specific than general objectives. Several program objectives taken collectively are a restatement of the general objective of which they are a subset. Program objectives identify discrete areas of learning within a discipline which must be addressed in the teaching - learning process. Specifically, program objectives:

a. Are subsets of general objectives.

b. Define a program elements in terms of student learning.

c. Are classified in one of the following categories:

(1) Knowledge

(2) Intellectual process

(3) Attitudes and values

(4) Psychomotor skills

d. Are applicable to one or more grade-level bands:

(1) K-2

(2) 3-6

(3) 7-9

(4) 10-12

3. Instructional Objectives: Instructional objectives are subsets of program objectives. They must be stated in terms which allow measurement of student competence with the objective. Several of these objectives collectively, are restatement of the Program Objective of which they are a subset. Specifically, instructional objectives:

a. Relate to a program objective.

b. Are stated in terms of observable or measurable student behavior.

c. Are classified in one of the following categories:

(1) Knowledge

(2) Intellectual process

(3) Attitudes and values

(4) Psychomotor skills

4. Enabling Objectives: Enabling objectives are subsets of

instructional objectives. They are the most specific objectives. They state student behavior in the most specific terms. Several of these objectives, collectively, are a restatement of the Instructional Objective of which they are a subset. They are day-to-day objectives used in classroom planning and are sometimes omitted from DoDDS objectives guides. Specifically, enabling objectives:

a. Relate to an instructional objective.

b. Are stated in terms of observable or measurable student behavior.

c. Are classified in one of the following categories:

(1) Knowledge

(2) Intellectual process

(3) Attitudes and values

(4) Psychomotor skills

The hierarchical relationships between the various objectives are shown in Figure 3.

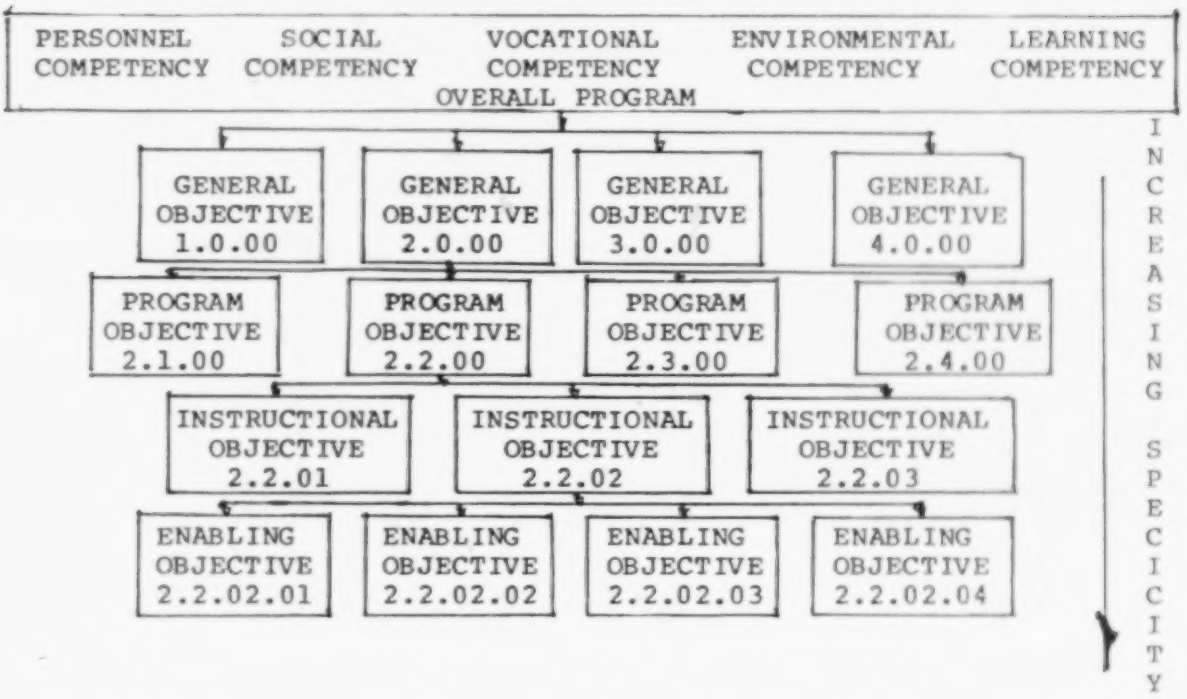


Figure 3. Functional Relationships Between Objectives

Examination of Figure 3 shows that all General Objectives are of equal value or weight; no particular General Objective is more important than any other General Objective. The same is true of Program Objectives and the same logic applies to the other levels of objectives.

WRITING INSTRUCTIONAL AND ENABLING OBJECTIVES

Instructional and enabling objectives are written in student centered terms; that is, they describe what student behavior should be following some period of instruction (class, course, program). While not written for each objective in a set of

objectives, when a viewer sees an objective he or she should automatically think: "as a result of instruction (class, course, program), students should be able to." Objectives, therefore, place emphasis totally on the degree to which classes, courses and programs impact student learning.

1. Parts. There are three generally accepted parts of an objective: stem, conditions and criteria.

   a. Stem: The stem always begins with a transitive (action) verb. Table 1 is a list of verbs used when stating general and program objectives. The list is not all inclusive.

Table 1

Examples Of Verbs For Program And Instructional Objectives

Analyze	Compute	Interpret	Perform	Translate
Apply	Create	Know	Recognize	Understand
Appreciate	Demonstrate	Listen	Speak	Use
Comprehend	Evaluate	Locate	Think	Write

In Table 2, we find a number of verbs useful when writing instructions and enabling objectives. The list is not all inclusive, but only a representative sample. An example of a stem would be: DO acid-base titrations.

Table 2

Examples of verbs for Instructional and Enabling Objectives

Alter	Paraphrase	Reconstruct	Rephrase	Rewrite
Ask	Predict	Regroup	Restate	Simplify
Change	Question	Rename	Restructure	Synthesize
Design	Rearrange	Reorganize	Retell	Systematize
Generalize	Recombine	Reorder	Revise	Vary
Modify				
Analyze	Conclude	Deduce	Formulate	Plan
Appraise	Contrast	Defend	Generate	Structure
Combine	Criticize	Evaluate	Induce	Substitute
Compare	Decide	Explain	Infer	
Choose	Detect	Identify	Match	Place
Collect	Differentiate	Indicate	Omit	Point
Define	Discriminate	Isolate	Order	Select
Describe	Distinguish	List	Pick	Separate
Apply	Demonstrate	Keep	Prepare	Specify
Calibrate	Dissect	Lengthen	Remove	Straighten
Conduct	Feed	Limit	Replace	Time
Connect	Grow	Manipulate	Report	Transfer
Convert	Increase	Operate	Reset	Weigh
Decrease	Insert	Plant	Set	
Aim	Designate	Include	Raise	Strike
Attempt	Determine	Inform	Relate	Suggest
Attend	Develop	Light	Repeat	Supply
Begin	Distribute	Make	Scratch	Support
Bring	Drop	Mend	Sharpen	Switch
Come	Expand	Open	Shoot	Tear
Complete	Extend	Pack	Shorten	Touch
Consider	Fit	Peel	Signify	Twist
Correct	Flip	Pin	Slide	Use
Crease	Grind	Position	Stock	
Crush	Guide	Produce	Store	

b. Conditions: When included, these are the conditions under which the behavior identified in the stem must be evaluated. An example is: Without the use of aids.

c. Criteria: A criterion is a standard of acceptable performance which identifies for teachers, a maximum level of performance students must demonstrate before

they are considered minimually competent with an objective. An example is: ten titrations in 20 minutes.

d. Combination: The combined objective which includes all three parts using the examples provided above should read: DO ten acid-base titrations in 20 minutes without the use of outside aids.

2. Content. We recognize at least four types of content objectives; procedures, rules, concepts and facts.

a. Procedure Objectives: A procedure is a set of sequential steps designed to solve specific problems always in the same way. procedures are:

(1) sequential steps used to attack a problem that always presents itself in the same way.

(2) needs to be performed in the same way. Procedure objectives may require students to only remember a set of steps or they may require students to usually use the steps to perform a task. Let's look at some examples.

(a) DESCRIBE the steps required to weigh a substance, using a single-arm, analytical balance without the aid of references. Here the sequential steps are the weighing procedure. The problem is how to weigh something using a single-arm analytical balance such that the procedure does not change. The mass of weighing paper, for example, is always determined prior

to actually measuring a specific amount of a particular dry chemical.

(b) WEIGH correctly a substance by using a single-arm analytical balance, given the filter paper and chemicals. In this case, the objective is the same as the first example except that the procedure this time must be implemented rather than merely remembered.

b. Rule Objectives: A rule is a set of sequential steps, intended to solve anyone of a class of problems, which can be demonstrated using a variety of examples. Let's use Ohm's laws as an example of a rule: Current flow is directly proportional to voltage and inversely proportional to resistance or $I=\frac{E}{R}$ (current = voltage/resistance). A rule (applies equally to all cases):

(1) is a set of sequential steps. Using Ohm's law we have to:

(a) determine the voltage

(b) determine the resistance

(c) divide voltage by resistance

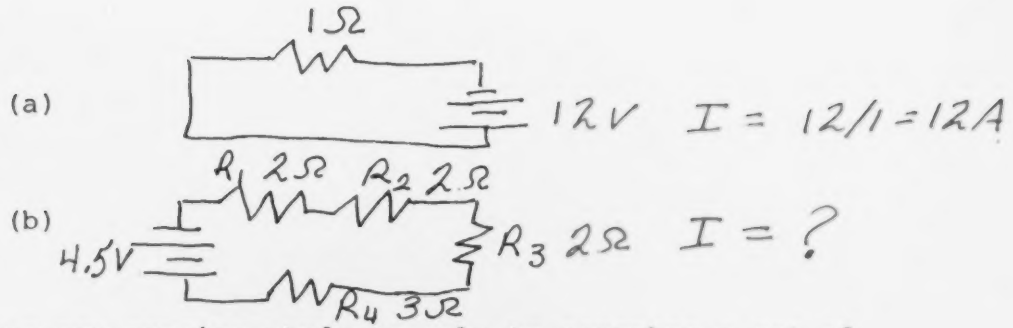
(2) is used to solve a class of problems;

(a) 10 volts; 5 ohms

(b) 12 volts; 4 ohms

(c) 50 volts; 2 ohms

(3) is demonstrated using a variety of examples;



Rule Objectives may require students only to remember a set of steps or they may require students to use a set of steps to perform a task. Let's look at some examples:

1. LIST correctly the steps for computing the resistance of a series resistance circuit without the aid of outside reference. The sequence of actions involved in computing resistance must be learned by the students. The sequence is designed to solve anyone of a class of problems and every series resistance problem is a member of the class.
2. COMPUTE, correct to the first decimal place, the resistance of a series resistance circuit given the current flow and the voltage of the circuit.

c. Concept Objectives: A concept is a group of elements which share common characteristics and a common name. A concept has elements or members having common characteristics. For example: (a) cat; (b) dog; (c) horse. The characteristics common to these members are; they are all, higher vertebrates, have hair on their bodies, suckle their young. Concept objectives may

require students to simply remember or they may dictate action or use the concept. Let's look at some examples:

(1) LIST, correctly, the defining characteristics of "trees" according to the "North American Tree Identification Guide" without using references. Here all we see are trees such as ashes, elms, maples, pines, etc., as members of the group all having common characteristics. Some of those characteristics are a central woody trunk, branches, and leaves.

(2) IDENTIFY, trees correctly, when given several trees but references. In this example, students must use rather than just remember the concept.

d. Fact objectives: Facts are arbitrarily or historically determined relationships between objects, symbols, or events. Here there is no general rule or set of characteristics that can be used to solve new problems or identify previously unencountered members of a class. Fact objectives do not involve systematic relationships. Let's look at an example of a fact objective: STATE the members of Genus Mytilus listed by Linneaus in Systema Natura 10th Edition 1753.

SUMMARY

This document was written for those individuals serving science objectives task groups. It provides some guidance for use when writing and rewriting science general, program, instructional and enabling objectives. It is not intended to be all inclusive source for use when writing behavioral objectives, but rather documents intended to stimulate thought.